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INFLUENCE OF FINISHING DIET ON FATTY ACID PROFILE OF LONGISSIMUS MUSCLE OF BLACK SLAVONIAN PIGS

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SUMMARY

Regarding nutritional recommendations for humans, pork in general has too high ratio of n-6 and n-3 polyunsaturated fatty acids. The n-6/n-3 index is particularly high if animals were intensively fed concentrate feeds, because the cereals like corn are rich in linoleic acid (C18:2 n-6). Traditional Black Slavonian pig production is an outdoor grazing system, which includes utilization of the natural resources of pasture and oak woodland with supplement of small amounts of corn or some other grains. However, fattening with corn-based concentrate mixtures before slaughter is common. In this study, the influence of finishing diet of acorn or corn-based mixture on fatty acid profile of longissimus muscle of Black Slavonian pigs was investigated. The indication of beneficial effects of acorn was found when Black Slavonian pigs were fed acorn instead of concentrate feed during pre-slaughter fattening. Feeding acorn ad libitum for a period of three weeks prior slaughter significantly increased the content of alpha linolenic acid (C18:3 n-3) in the longissimus muscle in comparison to concentrate fed pigs (0.37 vs. 0.12, respectively; expressed as % of total fatty acid methyl esters, $P \leq 0.01$). As a consequence, the n-6/n-3 ratio in the muscle of acorn finishing pigs was nearly threefold lower than in concentrate finishing pigs (24.1 vs. 69.3, $P \leq 0.01$).

Key-words: Black Slavonian pig, diet, acorn, muscle lipids, fatty acids

INTRODUCTION

In pigs, deposition of dietary fatty acids into tissue fat is preferential to endogenous synthesis (Hays and Preston, 1994; Moloney, 2002). Therefore, fatty acid deposition in pig fats largely reflects dietary fatty acid composition. Regarding nutritional recommendations for humans (Department of Health, 1994), pork in general has too high ratio of n-6 and n-3 polyunsaturated fatty acids (Enser, 2001; Higgs, 2002; Wood et al., 2003). The n-6/n-3 index is particularly high if pigs were intensively fed concentrate feeds, because the cereals like corn are rich in linoleic acid (C18:2 n-6). In contrast, natural resources feeds like grass are a good source of alpha linolenic acid (C18:3 n-3) (Muriel et al., 2002), n-3 fatty acid is believed to confer benefits to human health (Kralik et al., 2000; Newton, 2001). Acorns also can contain a noticeable amount of alpha linolenic acid (Petrović at al., 2004). Traditional Black Slavonian pig production is an outdoor system which includes utilization of the natural resources of pasture and oak woodland and foodstuff found on stubbles with supplement of small amounts of corn or some other grains. However, fattening with corn-based concentrate mixtures before slaughter is common. In this study, the influence of finishing diet of acorn of Slavonian oak (*Quercus robur* L.) or corn-based mixture on fatty acid profile of longissimus muscle of Black Slavonian pigs was investigated.

MATERIAL AND METHODS

Animals and diets

The investigation was carried out with ten heavy Black Slavonian pigs reared outdoors on pasture and additionally fattened in piggery with corn-based mixture for last two months.

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Three weeks before slaughter pigs were randomly divided and half of the animals were continued to be fed mixture diet while the other half was finished exclusively with acorn fed *ad libitum*. Acorns were previously collected from Slavonian oak (*Q. robur* L.) woodland. All the animals were slaughtered at about 154±22 kg and approximately 18 months of age. The chemical composition of finishing diets was determined by AOAC (1984) methods (Table 1).

Table 1. Chemical composition and major fatty acids of finishing diets

	Acorn	Mixture
Dry matter (%)	61.5	88.2
Crude protein[a] (%)	3.4	16.2
Crude fat[a] (%)	1.8	3.2
Crude fiber[a] (%)	8.9	2.4
Crude ash[a] (%)	1.2	5.1
Fatty acids[b] (%)		
C14:0	0.15	0.14
C16:0	18.09	17.54
C16:1	0.29	0.95
C17:0	0.12	1.05
C18:0	1.32	2.36
C18:1	30.52	24.85
C18:2 (n-6)	43.38	50.18
C18:3 (n-3)	4.58	1.92
C20:1	0.37	0.27

[a]Expressed as % of dry matter

[b]Expressed as % of fatty acid methyl esters

Meat quality, sampling, intramuscular fat and fatty acid analysis

After slaughtering the pH_1 and pH_{24} of *m.longissimus dorsi* were measured on the left side of carcass between 13th and 14th ribs by TESTO 230 pH meter (TESTO, Germany) with the penetration electrode (type 13) 45 min and 24h *post mortem*. Meat color was measured after 24h by transferable chroma meter MINOLTA CR 410 (measurement area ∅ 50 mm, illuminant D65, Minolta Camera Co. Ltd. Japan) using the system CIE LAB (CIE, 1976). The measurements were taken on fresh cut surface of cross section of longissimus muscle between 13th and 14th ribs after approximately 5 minutes of blooming time. Muscle sampling was carried out on cold halves. A portion of longissimus muscle (ca. 150 g) at the last rib of each animal was taken and stored frozen until analysis. Lipids were extracted from muscle by Stoldt method. Fatty acids composition of total lipids was determined by gas chromatography using Chrompack CP 9000 equipped with a flame ionization detector. Percentage of fatty acids was calculated according to Csapó et al. (1986) and expressed as percentage of total fatty acid methylesters.

Data analysis

Data from two finishing diet groups were compared by Student t - test using PROC TTEST (SAS, 1999). The F test indicated unequal variances for C18:0, C18:3 n-3, C20:3 and n-6/n-3 and presented p-values correspond to the t test result using the Satterthwaite method.

RESULTS AND DISCUSSION

Table 1 shows the chemical composition of finishing diets. Corn-based mixture diet had a higher proportion of C18:2 n-6 than acorn (50.18 vs. 43.38 %), while acorn had a higher proportion of C18:3 n-3 than mixture (4.58 vs. 1.92 %). The result for alpha linolenic acid content in *Q. robur* L. acorns was higher than previously reported (1.8 %) by Petrović et al. (2004) and higher than amounts of C18:3 n-3 (0.7-1.0 %) usually found in acorns of Mediterranean forest oaks (*Q. ilex*, *Q. rotundifolia* and *Q. suber*) (Cava et al., 1997; López-Bote, 1998). Meat quality and fatty acid profiles of intramuscular fat of *m. longissimus dorsi* from pigs fed different finishing diets are shown in Table 2.

Muscle pH, as well as color dimensions *L** (lightness) and *a** (red to green color), did not differ between finishing diets. However, the *b** (yellow to blue color) was significantly higher (P≤0.05) in muscles of pigs fed corn-based diet than in pigs fed acorn (6.18 vs. 3.15). This could be explained by carotenoids present in corn grain and relationship between CIE *b** and yellow plant pigments (Humphries et al., 2004). Intramuscular fat of *m.longissimus dorsi* was high in all pigs (6.6-7.2 %). High infiltration of fat into muscle is one of the distinctive traits of Black Slavonian breed in comparison to pork from modern breeds and present results confirm previous data obtained by Uremović et al. (2004) and Senčić et al. (2005). Increased accumulation of intramuscular fat could be also found in other non-improved pig breeds with a low genetical potential for depositing muscle during fattening, like Mangalica (Szente et al., 2005), Iberian (López-Bote, 1998) or Corsican pig breed (Coutron-Gambotti et al., 1998). Regarding fatty acid profile of longissimus muscle of Black Slavonian pigs fed acorn or corn-based mixture finishing diet, no major differences were found in the proportions of total saturated, monounsaturated and polyunsaturated fatty acids, as well as for ratio of polyunsaturated and saturated fatty acids (P/S). However, feeding acorn *ad libitum* for a period of three weeks prior slaughter significantly increased (P≤0.01) the content of alpha linolenic acid (C18:3 n-3) in the longissimus muscle in comparison to concentrate fed pigs (0.37 vs. 0.12 %, respectively). As a consequence, the n-6/n-3 ratio in the muscle of acorn finishing pigs was nearly threefold lower than in concentrate finishing pigs (24.1 vs. 69.3, P≤0.01). Although the n-6/n-3 ratio was higher than nutritional recommendations (Department of Health, 1994) in both groups, these results suggest that substituting an acorn for corn-based mixture in finishing diet may reduce this ratio in pork. It is known, in general, that feeding n-3 fatty acids enriched diets to pigs increases the share of polyunsaturated fatty acids in the tissues. This, in turn, can lower oxidative stability of tissue lipids, which may have negative effects on shelf life, color and/or aroma of meat (Gray et al., 1996; Shahidi, 2002). In addition, technological quality of back fat can be impair when share of total polyunsaturated fatty acids is excessive (Warnants et al., 1998). Such problems could be controlled by feeding increased levels of vitamin E. In this study, oxidative stability and eating quality of meat were not evaluated. However, the concentration of n-3 fatty acids in muscles of pigs fed acorn for three weeks before slaughter was below the level at which abnormal pork flavors were usually perceived (Wood et al., 2003).

Table 2. Meat quality and fatty acid profiles of intramuscular fat of *m.longissimus dorsi* from pigs fed acorn and mixture (corn) finishing diets

Muscle traits	Finishing diet		P – value
	Acorn	Mixture (corn) feed	(2-sided)
pH1	6.25 (0.38)	6.11 (0.19)	0.495
pH2	5.86 (0.07)	5.88 (0.12)	0.803
Lightness (*L**)	49.35 (6.61)	50.51 (3.93)	0.743
Redness (*a**)	19.74 (1.95)	20.30 (0.70)	0.559
Yellowness (*b**)	3.15 (1.07)	6.18 (2.08)	0.020
Dry matter %	29.74 (1.42)	30.08 (2.16)	0.776
Intramuscular fat[a]	6.55 (1.56)	7.19 (2.81)	0.672
C14:0	1.44 (0.10)	1.31 (0.14)	0.125
C16:0	24.95 (0.63)	24.63 (0.96)	0.557
C17:0	0.35 (0.08)	0.37 (0.05)	0.660
C18:0	11.48 (0.39)	10.13 (1.80)	0.339
Total saturated	38.22 (0.99)	38.68 (2.59)	0.723
C16:1	3.66 (0.21)	3.12 (0.43)	0.035
C18:1	47.89 (1.35)	48.69 (1.18)	0.346
C20:1	1.05 (0.06)	1.12 (0.12)	0.303
Total monounsaturated	52.60 (1.45)	52.93 (1.64)	0.747
C18:2 n-6	7.48 (1.12)	6.81 (1.48)	0.444
C20:2 n-6	0.37 (0.06)	0.33 (0.09)	0.485
C20:3 n-6	0.14 (0.02)	0.17 (0.07)	0.496
C20:4 n-6	0.80 (0.18)	0.97 (0.26)	0.263
Total n-6	8.79 (1.26)	8.28 (1.86)	0.623
C18:3 n-3	0.37 (0.09)	0.12 (0.01)	0.003

Total polyunsaturated	9.17 (1.34)	8.40 (1.86)	0.475
P/S[b]	0.24 (0.04)	0.22 (0.06)	0.499
n-6/n-3	24.10 (3.89)	69.26 (16.41)	0.003

Each value is the mean (standard deviation) of 5 animals

[a]Expressed as % of dry matter

[b]Polyunsaturated/Saturated

CONCLUSION

Considerable amount of alpha linolenic acid, n-3 polyunsaturated fatty acid important in the prevention of cardiovascular diseases, was found in acorns of Slavonian oak (*Quercus robur* L.). Indication of beneficial effects of acorn was found when Black Slavonian pigs were fed acorn instead of corn-based concentrate during pre-slaughter fattening. Feeding acorn lowered the n-6/n-3 ratio in the meat, being of interest from the consumer's health point of view. Additional researches however are needed. Both, muscle and fat tissue of Black Slavonian pigs should be studied in detail with special emphasis on influence of traditional feedstuffs (pasture and acorn) and rearing conditions on fatty acid profile and quality of meat and fat.

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